Software Defined Networking

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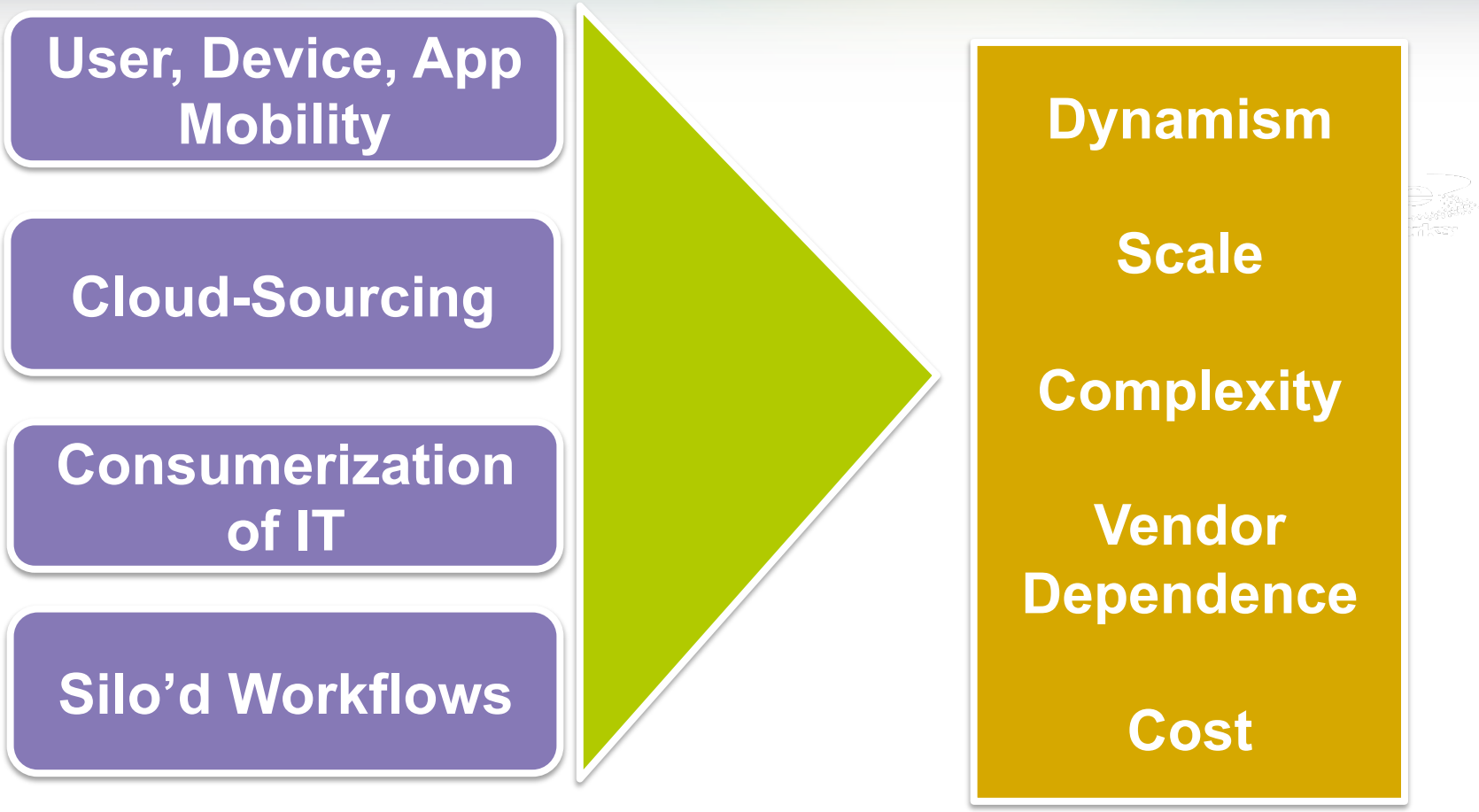
SDN Drivers



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Remember the Mainframe?

- Vertically integrated
- Closed, proprietary
- Slow innovation
- Controlled industry

App | App | App | App

Programmable Open Interface

Windows (OS) or Linux or Mac OS

Open Interface

Commercial Off The Shelf Microprocessor

- Open interfaces
- Rapid innovation
- Broad industry Participation

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What is SDN: Networking

App | App | App | App

Open Interface

Control Plane or Control Plane or Control Plane

Open Interface

Merchant Switching Chips

- Tight Vertical integration
- Closed, proprietary
- Slow innovation
- Tightly controlled

- De-coupling of Layers
- Open interfaces
- Rapid innovation
- Broad Industry Opportunity

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Software Defined Networking (SDN) Model

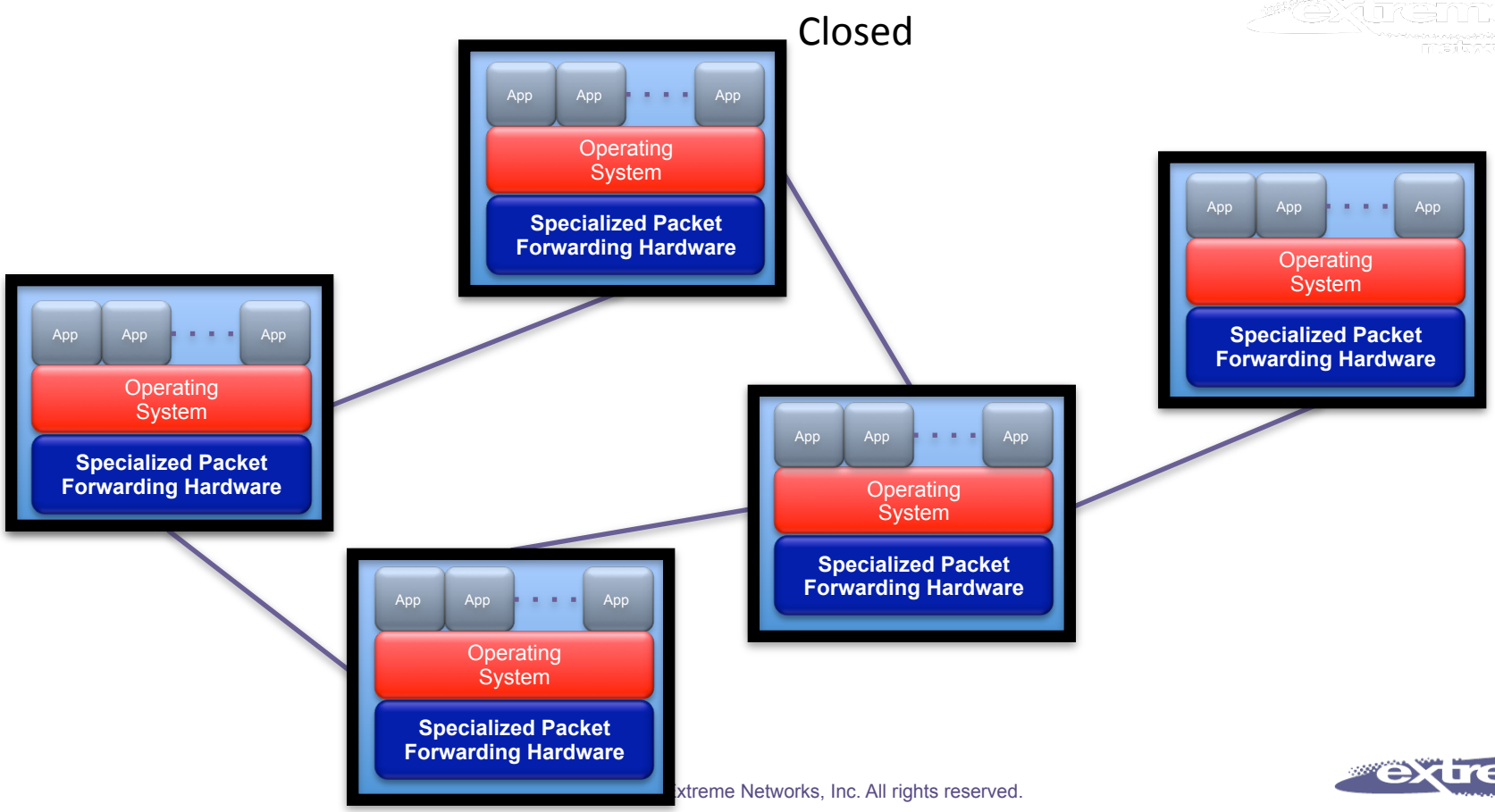
Make Control and Management Plane Programmable

Centralize Network Intelligence

Abstract Network Infrastructure for Applications

Separate Control Plane from Data Plane

Today – Closed Boxes, Fully Distributed Protocols



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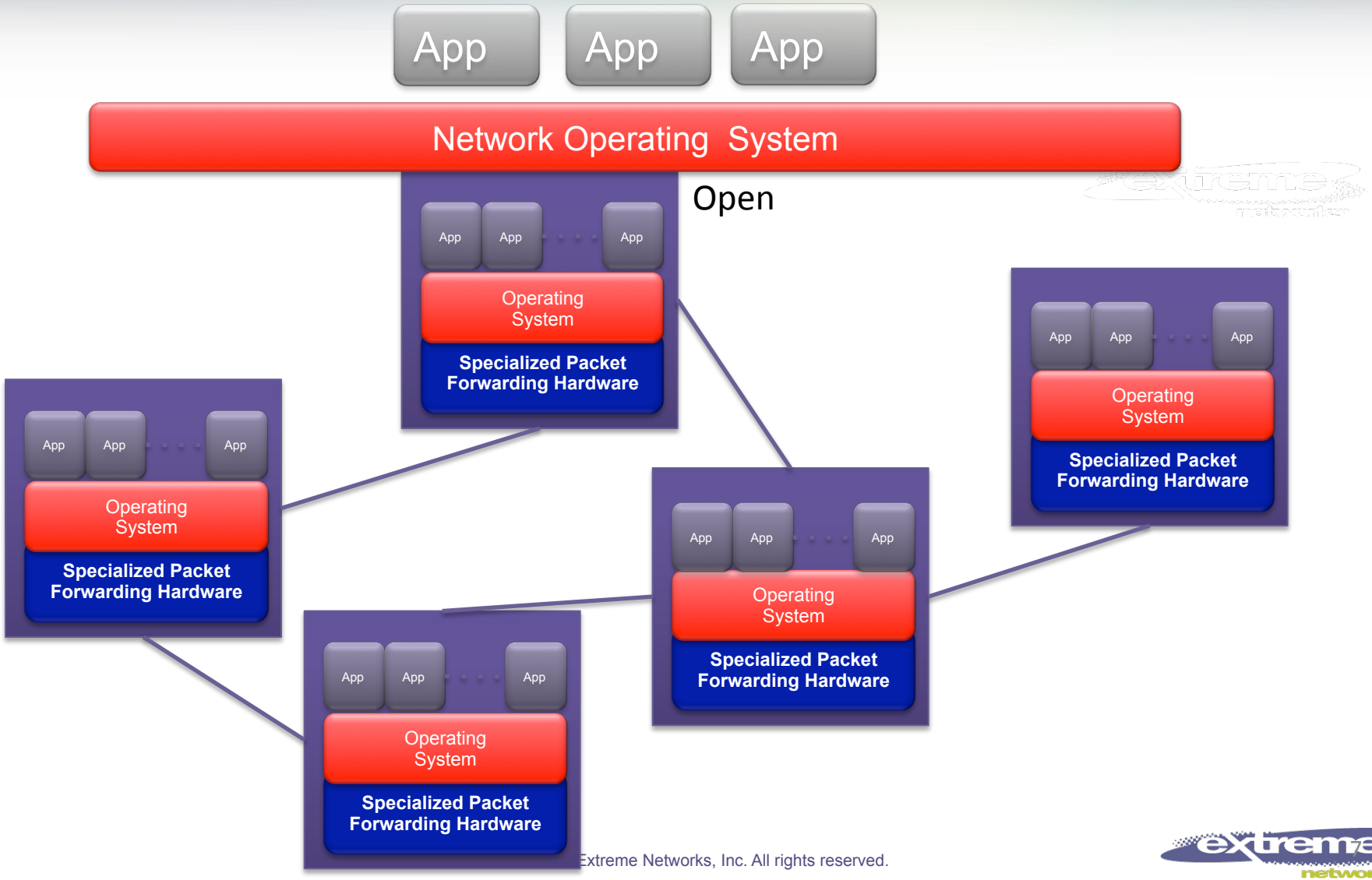
Another Approach – Centralized Control



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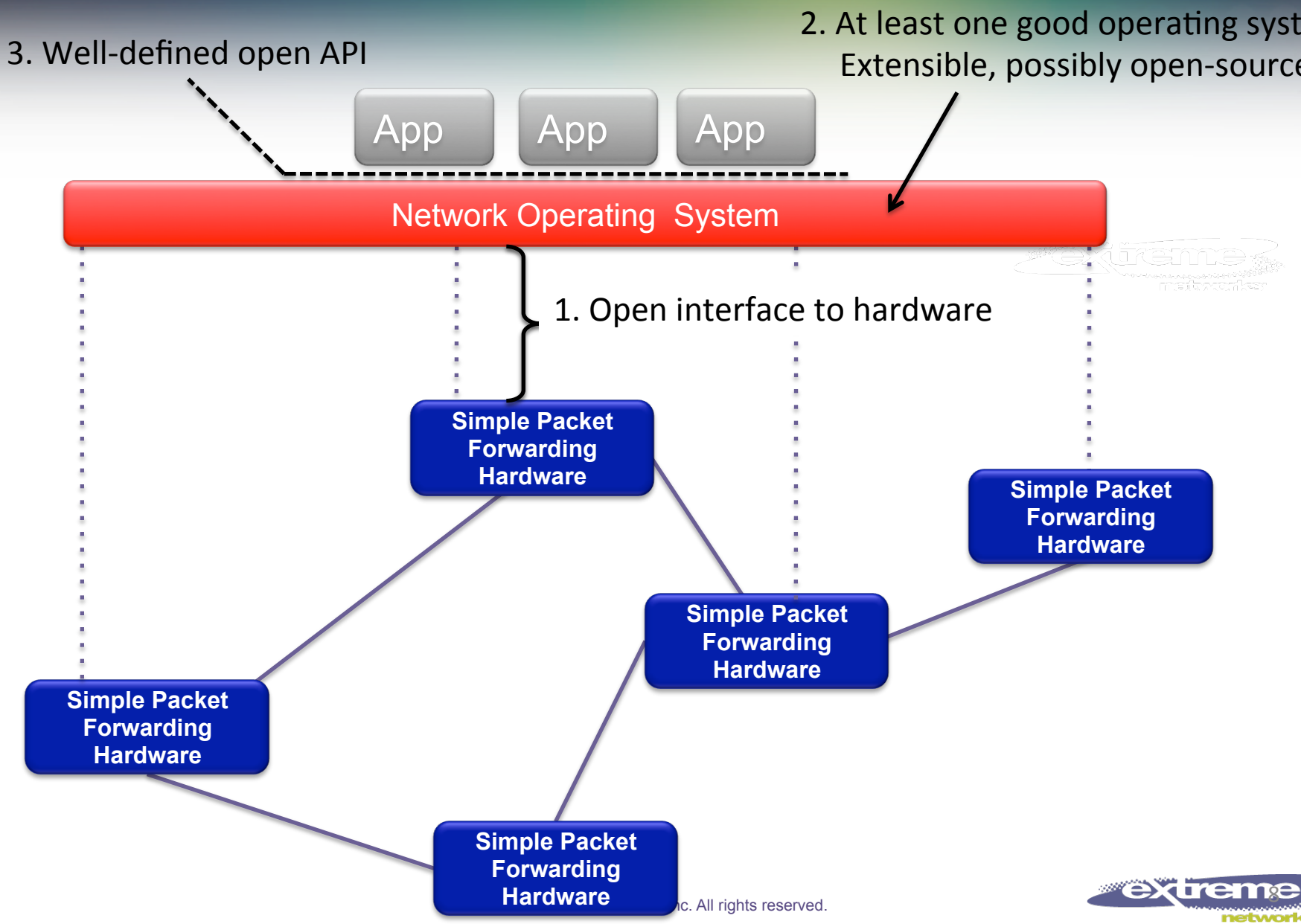
The "Software-defined Network"



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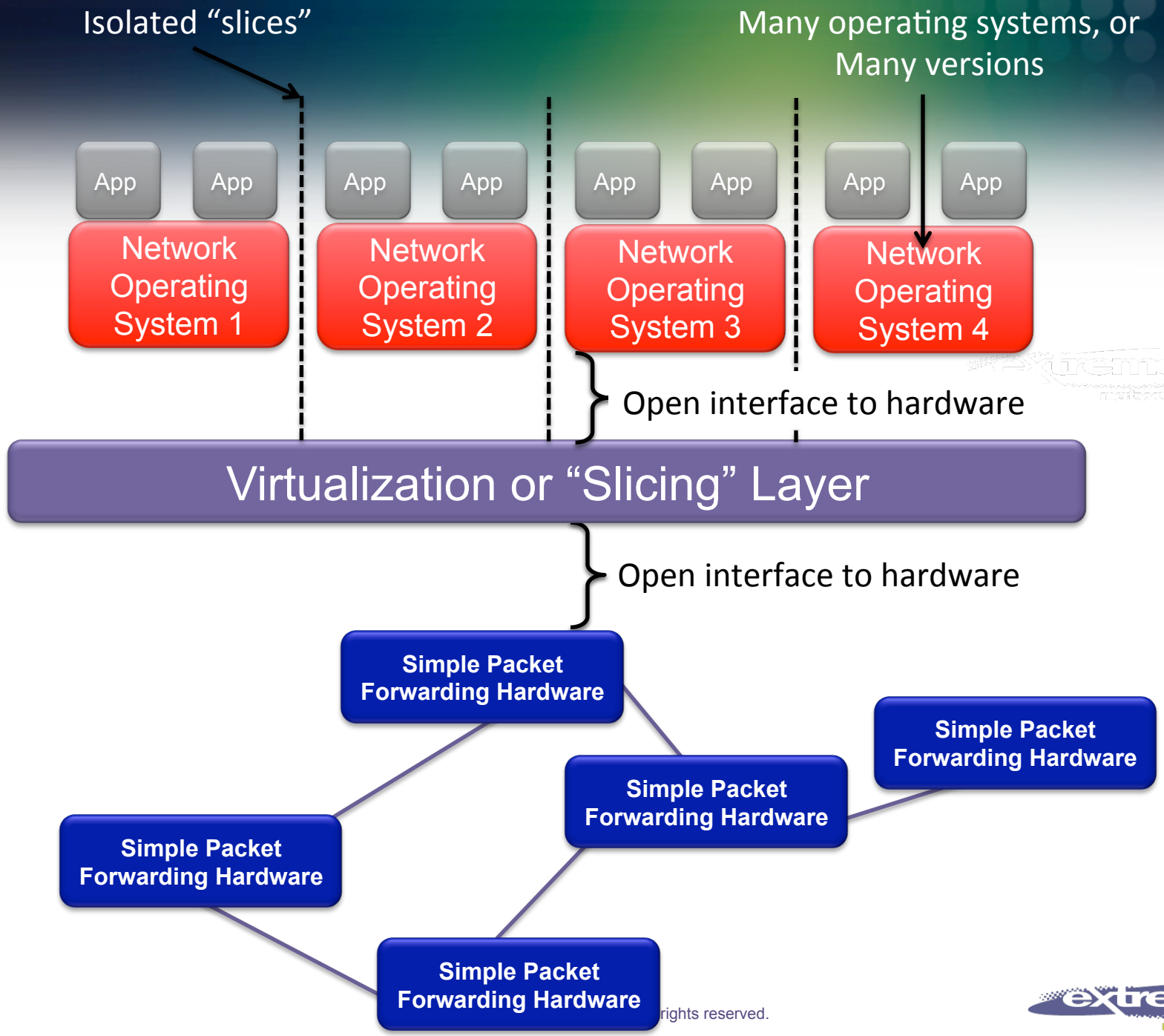

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Extreme Networks SDN Approach

SDN Apps

- VM Lifecycle Management (XNV)
- User Identity Management
- BYOD
- Application Performance Management
- ….

Management Platforms

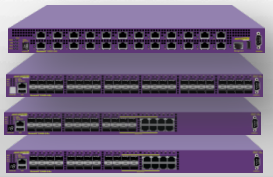
- Ridgeline
- OpenFlow
- openstack™ CLOUD SOFTWARE

XOS – Extensible, Open Secure

- XML
- Scripts
- External App SDK
- OpenStack Quantum Plugin
- OpenFlow

- Modular
- Predictable Performance
- Memory Protected
- Hardware Abstracted

High Performance Converged Open Fabric



- Low Latency
- High Capacity
- MLAG
- DCB

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Programmability: New Open Interfaces For SDN

Extending SDN Strategy with OpenFlow

- Support for OpenFlow across all Ethernet Switch products
- Powered by ExtremeXOS
- Will be available as a dynamically downloadable module
- Hybrid mode of operation

Open Multi-Vendor Approach to SDN

- Supporting multiple OpenFlow controllers

Extending SDN Strategy with Openstack

- Support for OpenStack Quantum with Plug-In

Creating SDN Developer Community Portal with XKit

- Launching Xkit for collaborative
- Programmable Network Applications

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SDN (OpenFlow) Details

What is OpenFlow?

OpenFlow is a protocol that allows an external node to control the forwarding tables of a switch.

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What is OpenFlow?

- Started 2008 at Stanford University
- Is now driven by Open Networking Foundation(ONF)
- ONF has over 70 members including:
  - Extreme Networks
  - Broadcom
  - Google
  - Microsoft
  - Yahoo
  - Facebook
  - Deutsche Telekom
  - …..

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What is OpenFlow?

- Definitions:
  - **OpenFlow-only switch**: supports the mandatory client features of the OpenFlow protocol.
  - **OpenFlow-capable switch**: supports the mandatory client features of OpenFlow in addition to normal switch functions (e.g., STP, EAPS).
  - **Controller:** supports the server feature of the OpenFlow protocol. Manages the forwarding behavior of one or more OpenFlow switches.
  - **Flow entry**: the basic unit of forwarding management.
  - **Flow table:** consists of a set of priority ordered flow entries. A switch may support more than one flow table.
  - **Emergency flow table**: flow table that the switch uses in case connectivity with all configured controllers fails.
- A switch may simultaneously connect to multiple Controllers, but only one controller is master.
  - **Flowvisor:** can be used to slice a switch into multiple logical switches, each managed by a different Controller.

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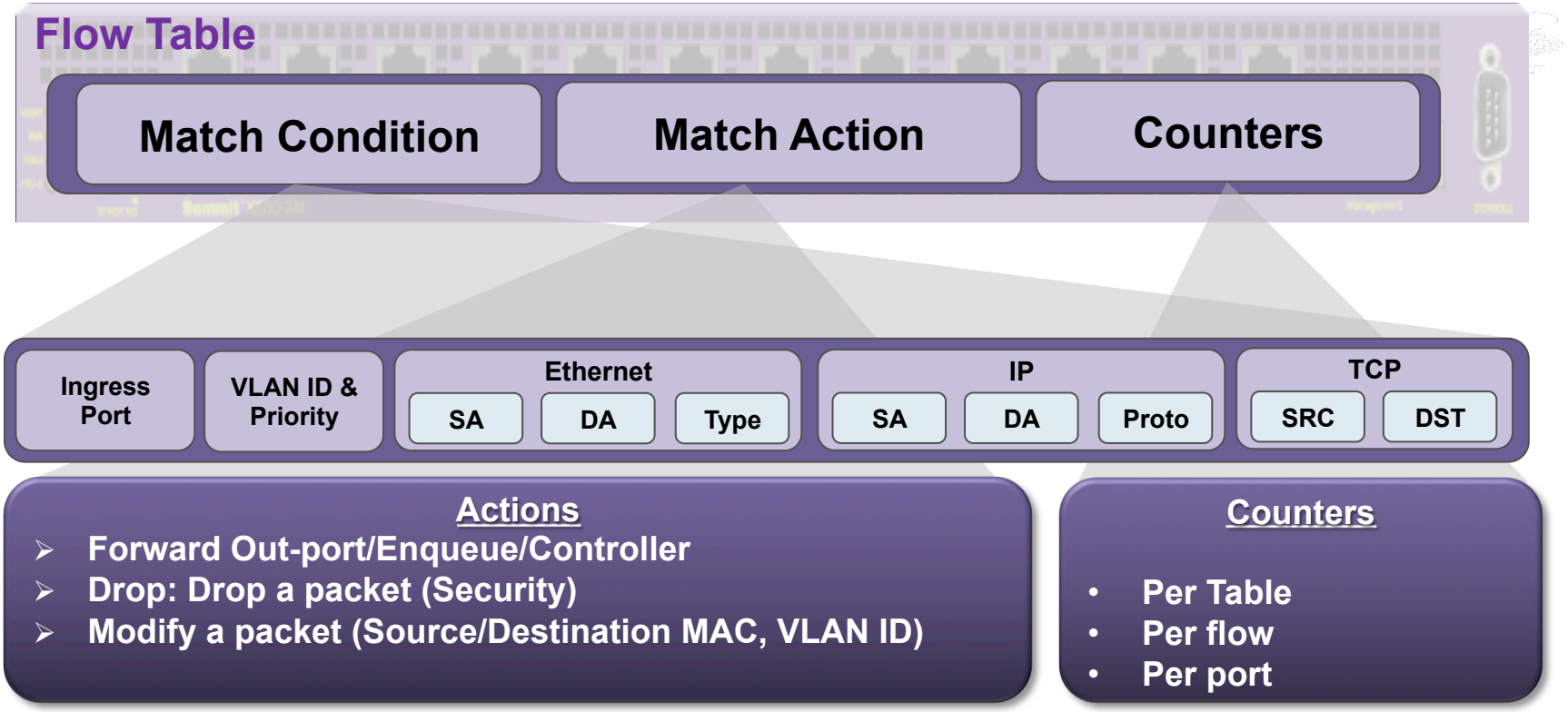
New Programmable Interfaces For SDN: OpenFlow

- OpenFlow 1.0 API XMOD; Hybrid Support
- OpenFlow controller redundancy; Out-of-band management port



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Flow Entry Actions

- Forward: forward packet to the following physical or virtual ports:
  - Output port: forward to a specified physical output port
  - ALL: forward to all ports, excluding the incoming port
  - CONTROLLER: encapsulate packet (Packet-In message) and send it to the controller
  - LOCAL: forward via the switch's local networking stack
  - TABLE: perform actions in the flow table (for Packet-Out messages only)
  - IN_PORT: forward the packet back out of the incoming port
  - NORMAL (optional): forward according to the traditional forwarding path (e.g., generated by STP + learning)
  - FLOOD (optional): flood the packet along the minimum spanning tree, excluding the incoming port
- Drop: drop the packet
- Enqueue (optional): enqueue the packet in a specified output port queue.
- Modify-Field (optional): modify a header field

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Flow Entry Modify Actions

- Set VLAN ID
- Set VLAN Priority
- Strip VLAN header
- Modify Ethernet MAC SA
- Modify Ethernet MAC DA
- Modify IPv4 SA (and update IPv4/TCP/UDP checksum)
- Modify IPv4 DA (and update IPv4/TCP/UDP checksum)
- Modify IPv4 ToS (DSCP)
- Modify TCP/UDP source port
- Modify TCP/UDP destination port

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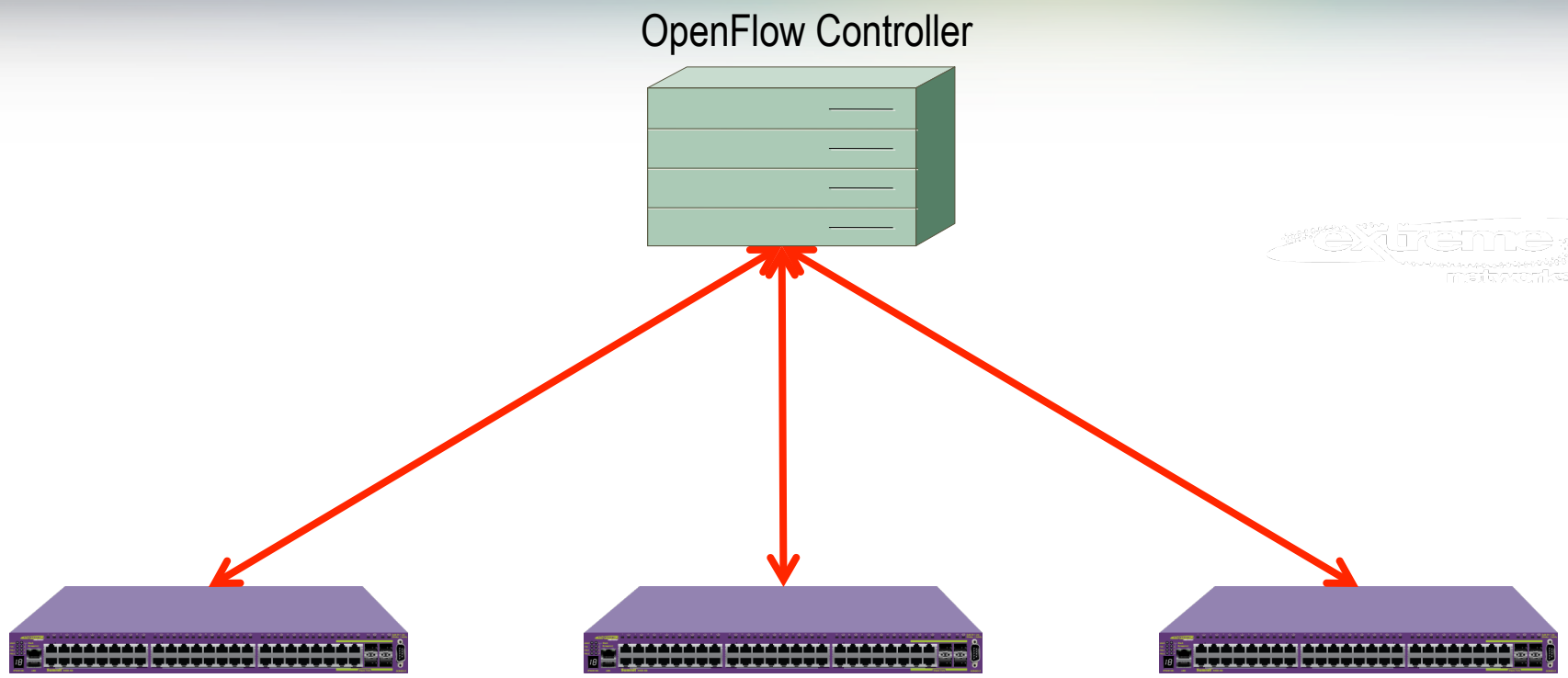
OpenFlow Startup Example



- Switch connects to controller. Both exchange Hello's. Version negotiation.
- Controller requests features with Features-Request.
- Switch responds with Features-Reply to indicate supported features and OpenFlow-enabled ports.

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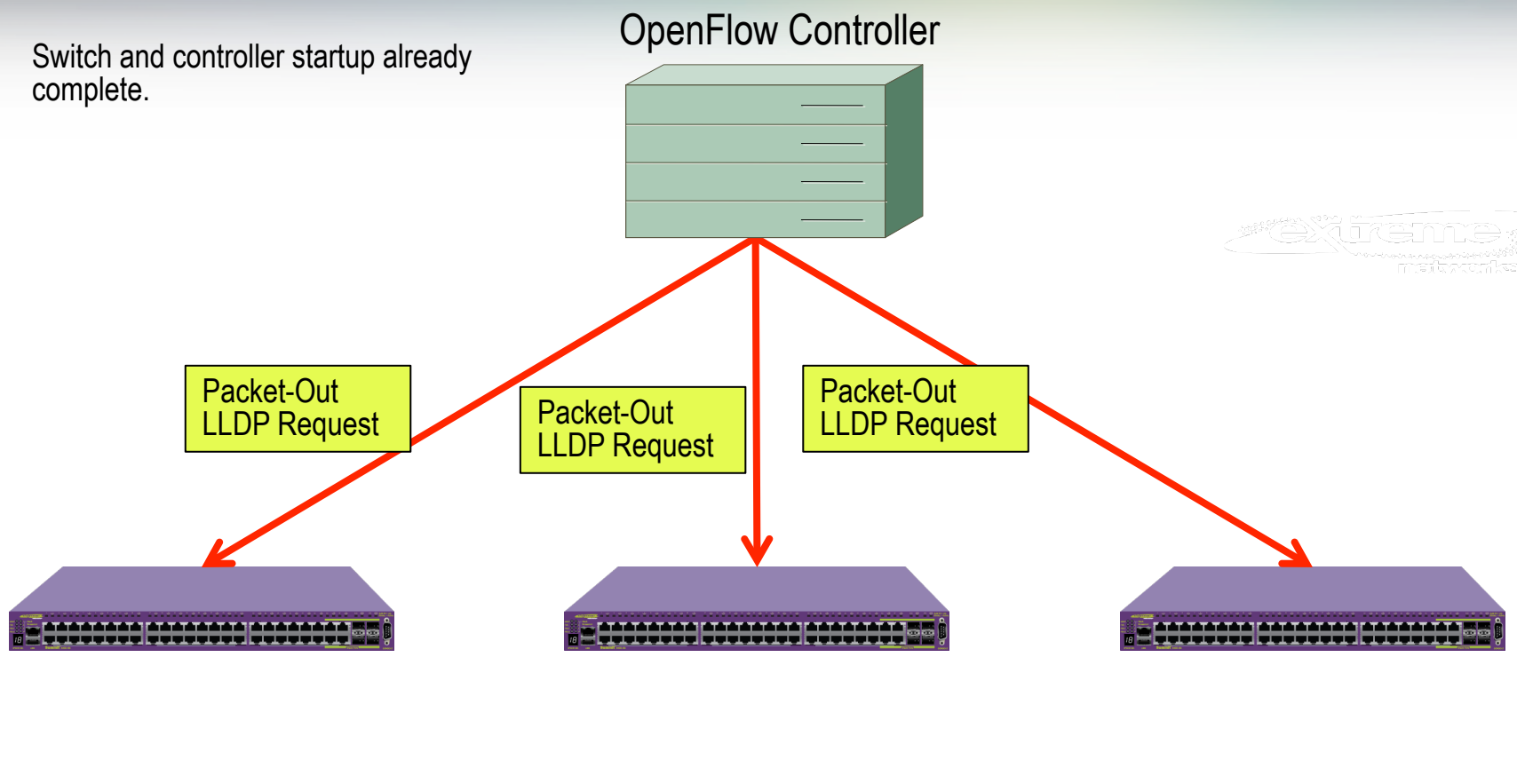
Topology OpenFlow Application Example

Switch and controller startup already complete.



Controller discovers topology of the network by forwarding LLDP's out to the switching and inspecting the replies.

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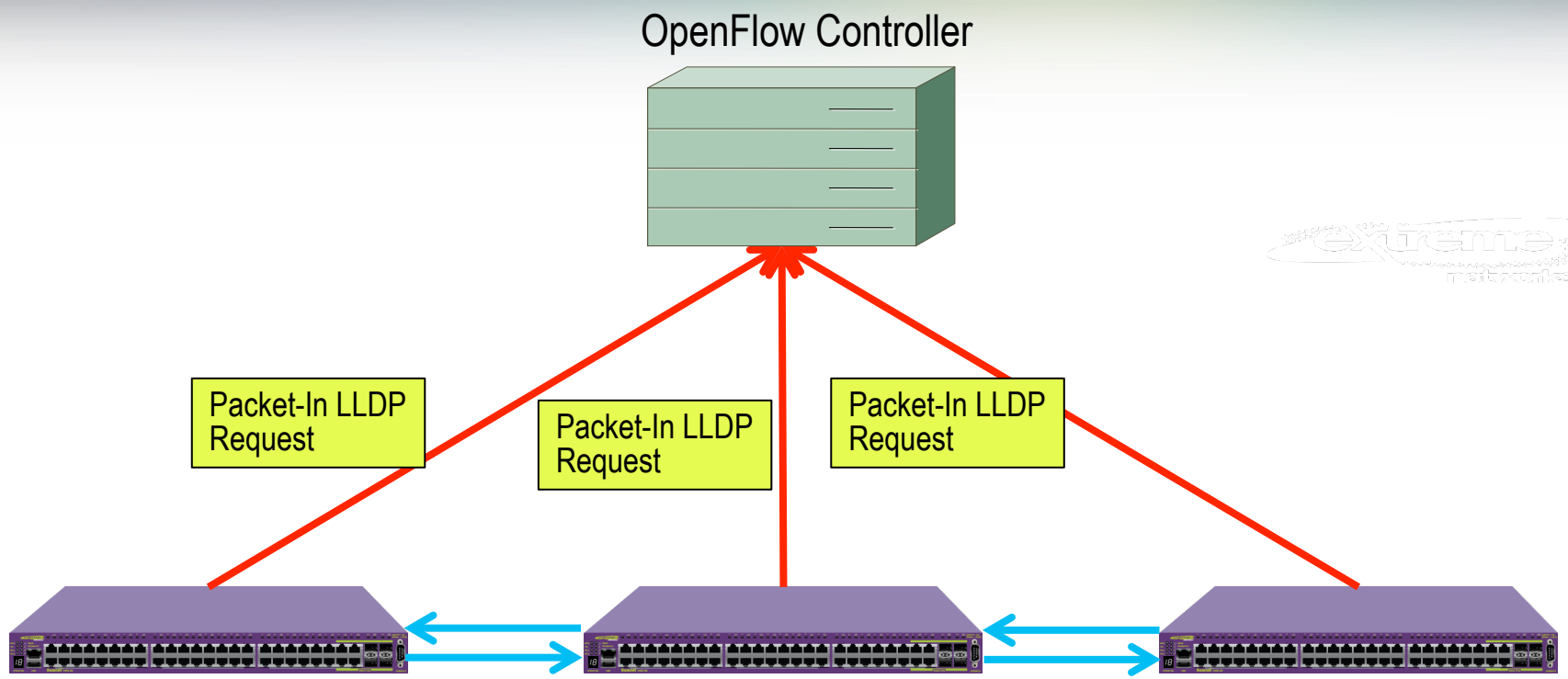
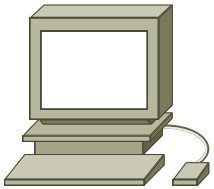
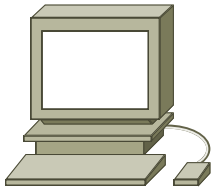
Topology OpenFlow Application Example





A

- Each switch forwards the LLDP's out the indicated ports.
- Each switch forwards the LLDP's to the controller as Packet-in's.
- Controller now knows the network topology.



B

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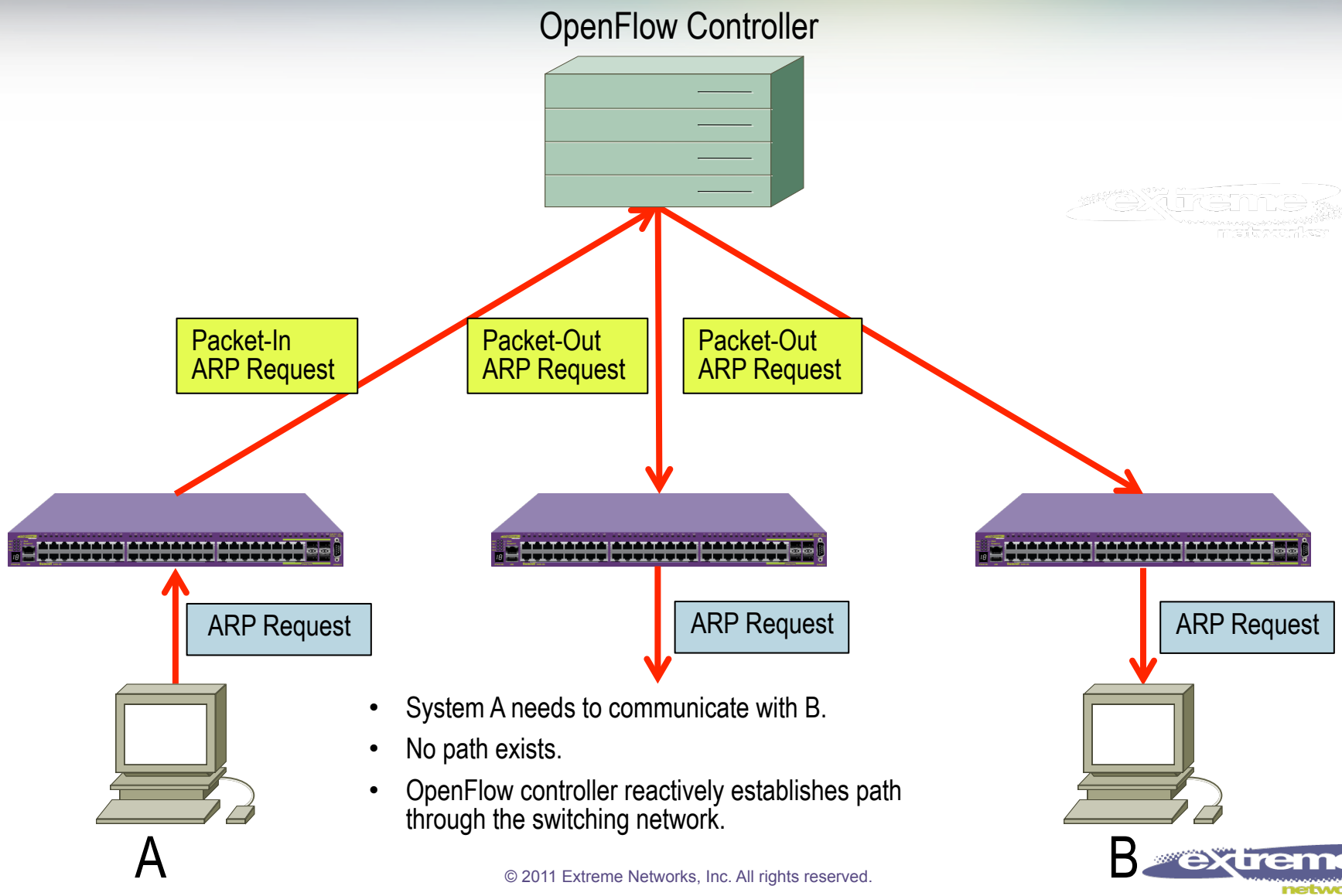
Reactive OpenFlow Application Example



- System A needs to communicate with B.
- No path exists.
- OpenFlow controller reactively establishes path through the switching network.

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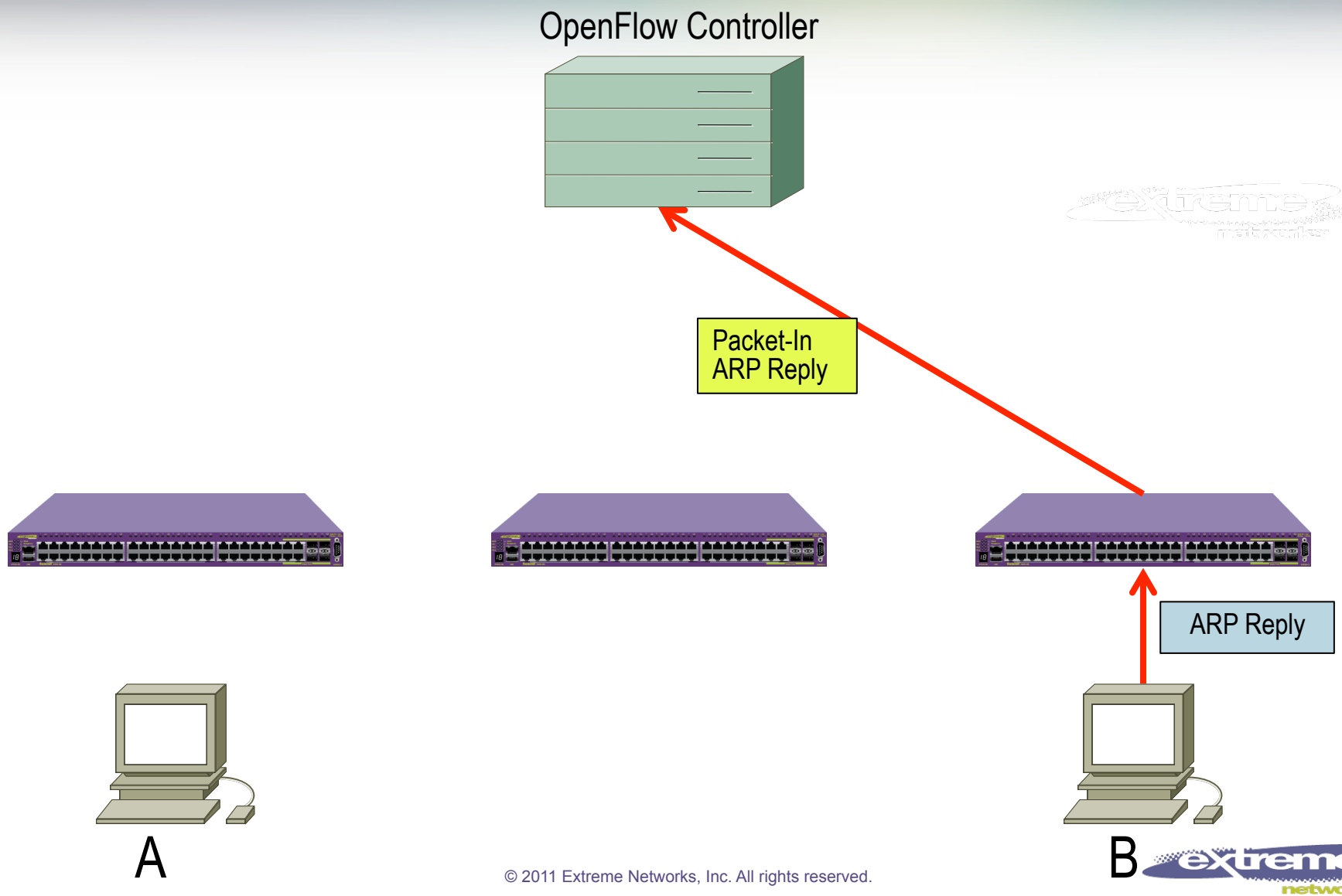
Reactive OpenFlow Application Example



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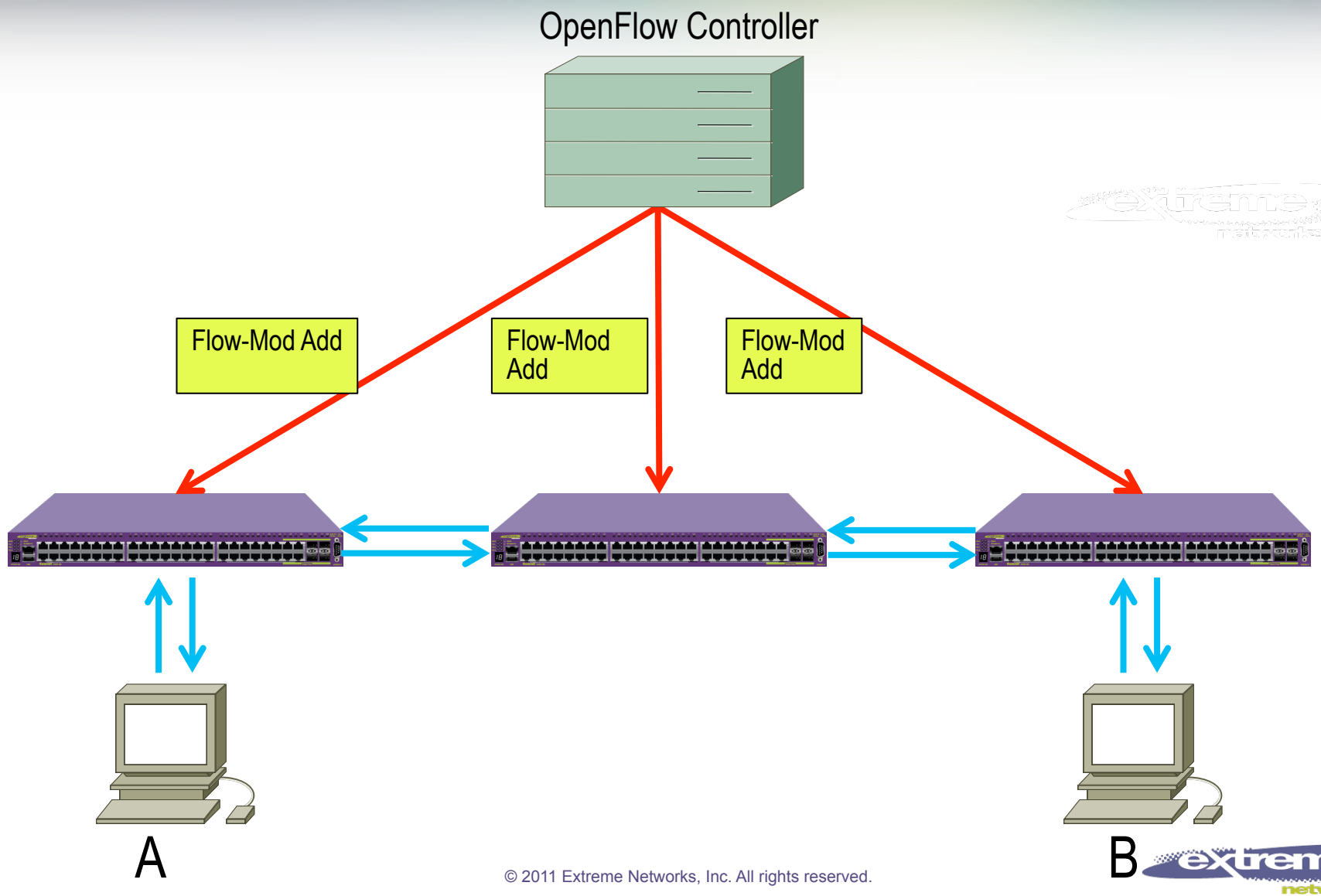
Reactive OpenFlow Application Example



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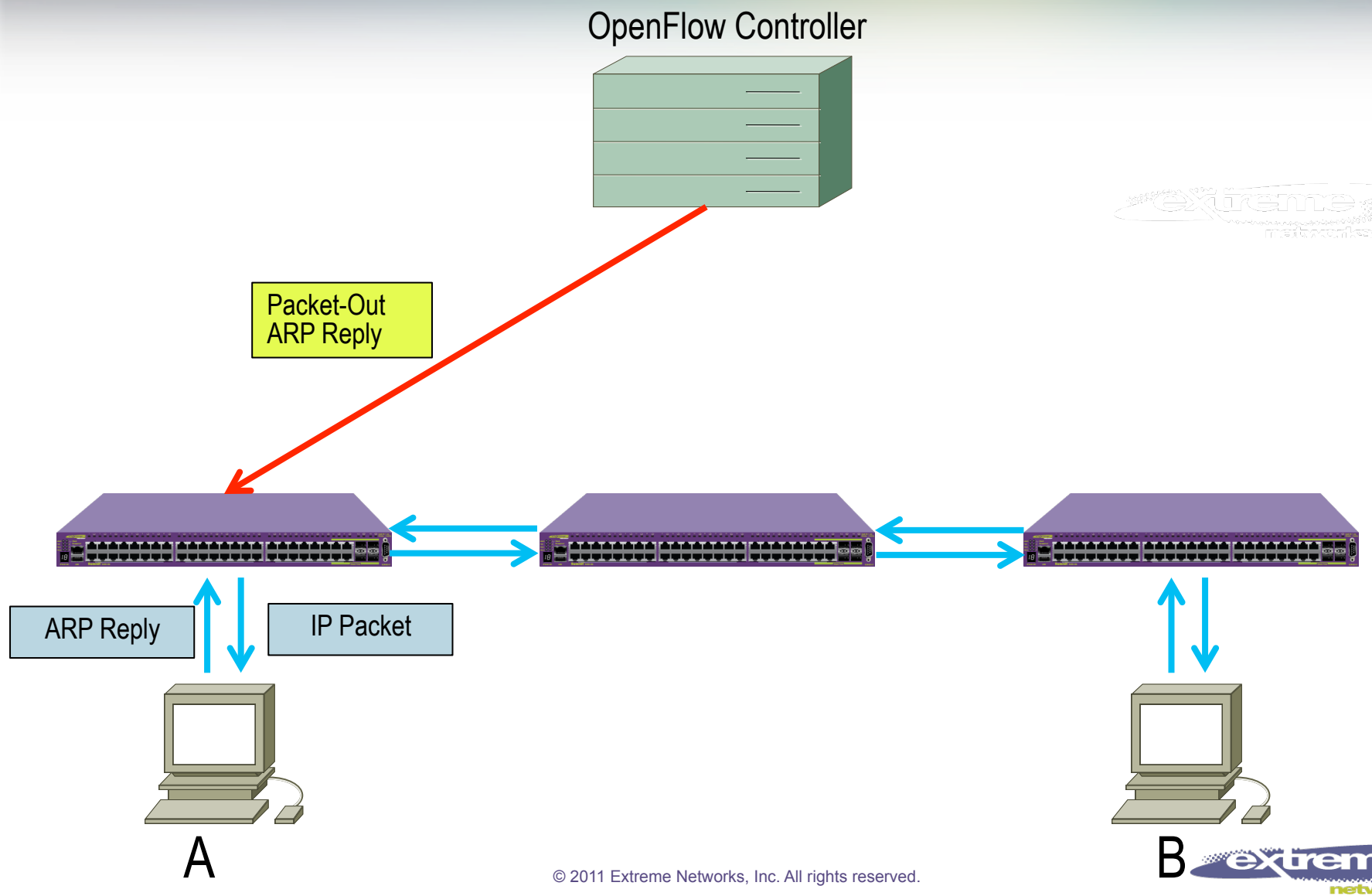
Reactive OpenFlow Application Example



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Extreme Networks SDN Controlled Fabric *in action*

SDN Community Portal – XKIT

Crowdsourcing, Network Applications store

Open Multi-vendor Approach

BigSwitch, NEC, Floodlight Controller etc.

Extending SDN with OpenStack

Network-as-a-service, Quantum Plugin

Enabling SDN with OpenFlow

OpenFlow 1.0 API, XMOD, Hybrid Support

Key SDN OpenFlow Features in EXOS

Open vSwitch (OVS) based OpenFlow	*Robust implementation based on OVS Long Term Support (LTS)*
Advanced Traffic Management	*Traffic distributed using LAG hashing* *Queuing support based on EXOS profiles*
Multiple Tables for Deployment Flexibility	*FDB based flows for simple L2 flows – Higher Scale* *ACL based flows for complex match & set conditions*
Multiple VLANs with Edit actions	*Simple OF based routing between VLANs* *Support Applications requiring control of multiple VLANs*
MAC Address Rewrite	*Rewrite source and destination MAC* *Support L3 SDN applications requiring MAC rewrite*

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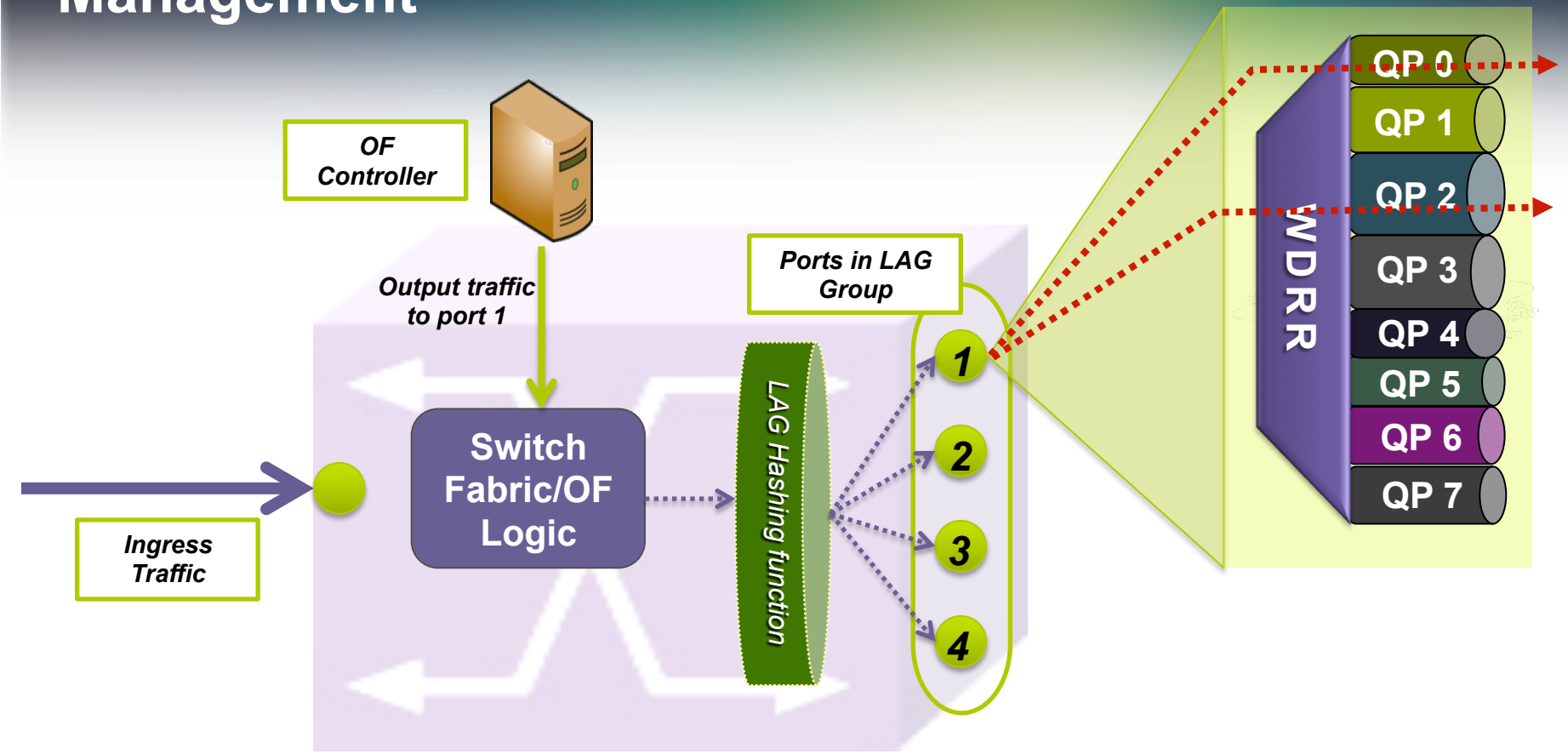
EXOS SDN Differentiation: Advanced Traffic Management



OpenFlow traffic distributed using LAG hashing function, instead of one port

OpenFlow traffic distributed through different QoS Profiles on egress port

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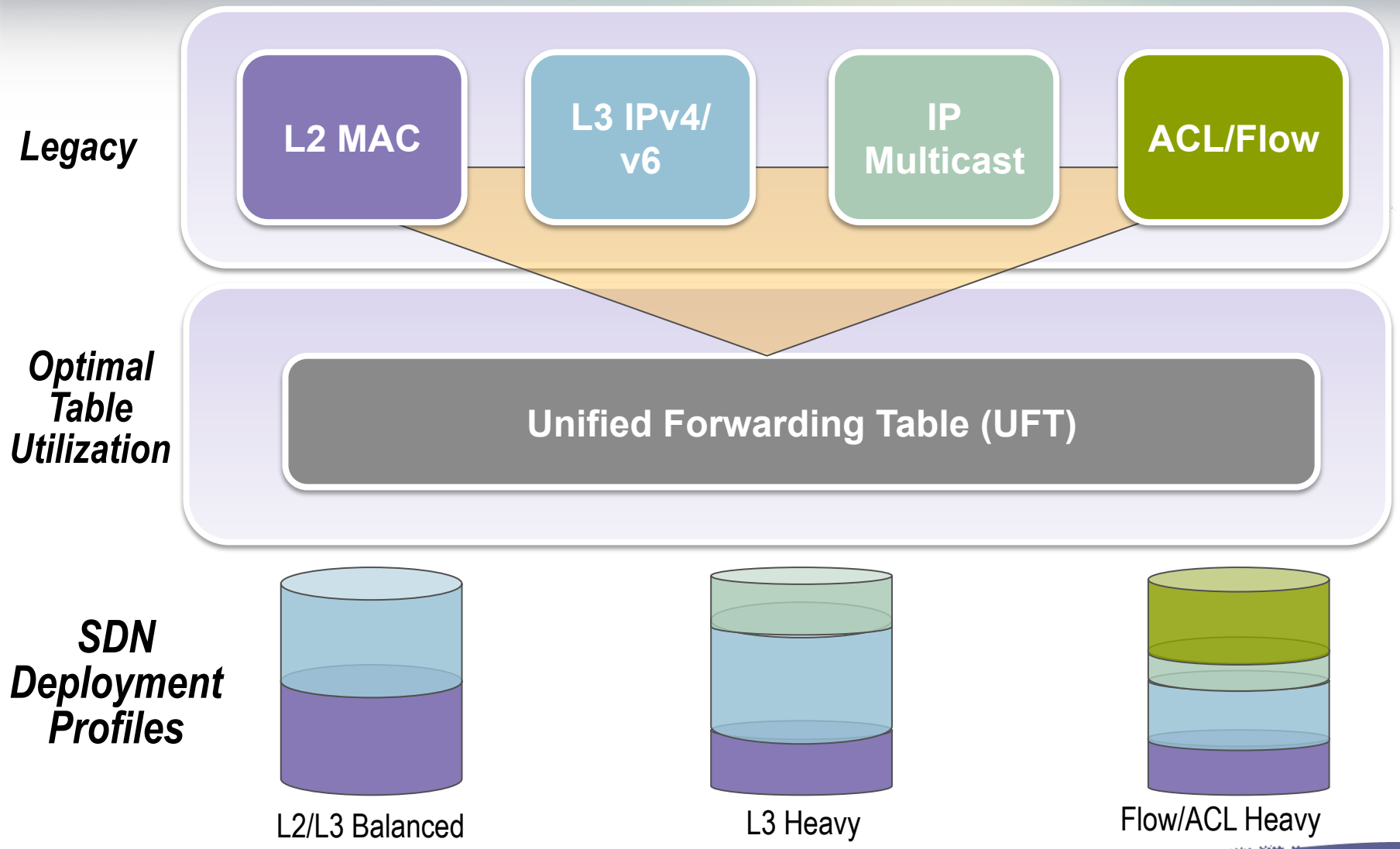
SDN OpenFlow: Deployment Flexibility with Unified Forwarding Table



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SDN OpenFlow: Multiple Tables for Deployment Flexibility

OpenFlow needs flow oriented architecture scaling requirements

L2 MAC	***FDB Tables can be used for macro flows that doesn't need finer-granular traffic control***
L3 IPv4/v6	***LPM Tables can be used for some complex flows involving IP address match conditions***
ACL/Flow	***ACL Tables can be used for micro flows that requires finer granular control of traffic with complex match and set conditions***

OpenFlow abstracts all these tables into one table. From controller's perspective, OpenFlow behaves as if there is a single table

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X-Kit: Application Portal

Crowd-Sourced Knowledge Base for SDN Applications

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SDN Differentiations

Extreme Networks has specific capabilities that provide clear differentiation among competition. **Shipping TODAY !**

Hardware Link Aggregation

- EXOS represents the LAG as a single virtual interface to the OpenFlow controller enabling bandwidth scaling, load balancing and link redundancy

Hybrid Mode Support

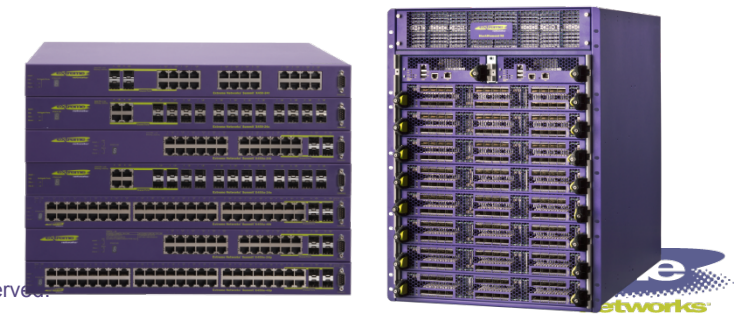
- Standard Ethernet switching and OpenFlow based forwarding on a “per-vlan” basis.

Hardware Quality of Service

- Configured profile queues are reported to the OpenFlow controller, enabling flows to be programmed directly to hardware queues.

Automated Flow Management

- EXOS intelligently classifies and maps flows to hardware resources, both the ACL and FDB tables, allowing up to 100,000 flows per switch.



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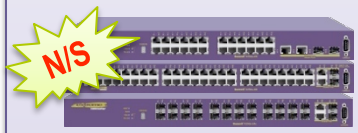
Extreme Networks Products & SDN Support

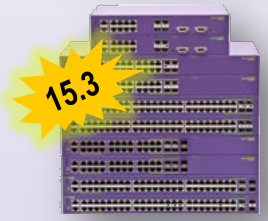
Campus Enterprise

Summit X350

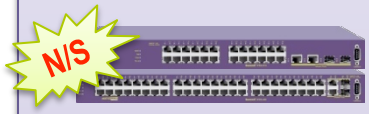
Summit X450a/e



Summit X250e



Summit X440

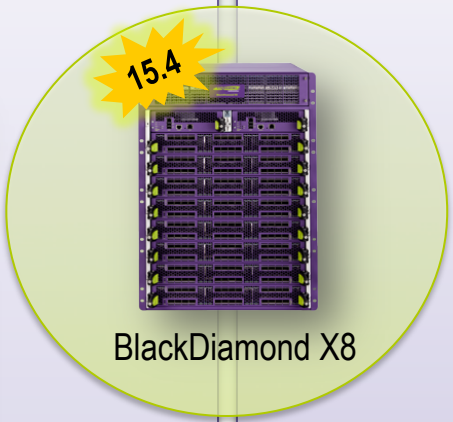


Summit X150

WM3xxx

Altitude 45xx/
46xx/47xx

Altitude 4511



BlackDiamond X8

BlackDiamond 8800

Data Center

Summit X670

Summit X480

Summit X650

Summit X460

Mobile Backhaul

E4G-200

E4G-400

POWERED BY ExtremeXOS™

N/S: Not Supported

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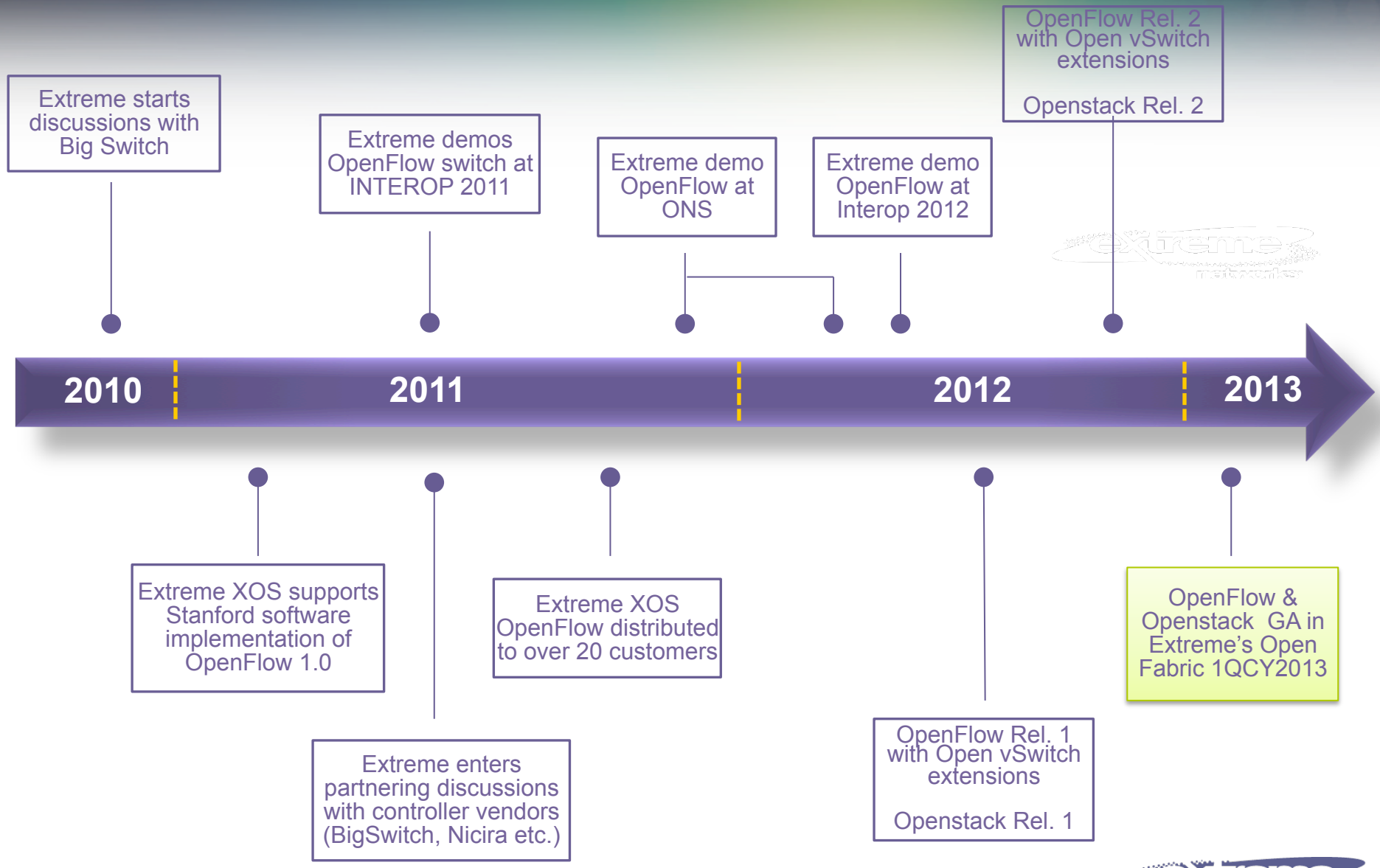
SDN Technology Leadership *Continues….*



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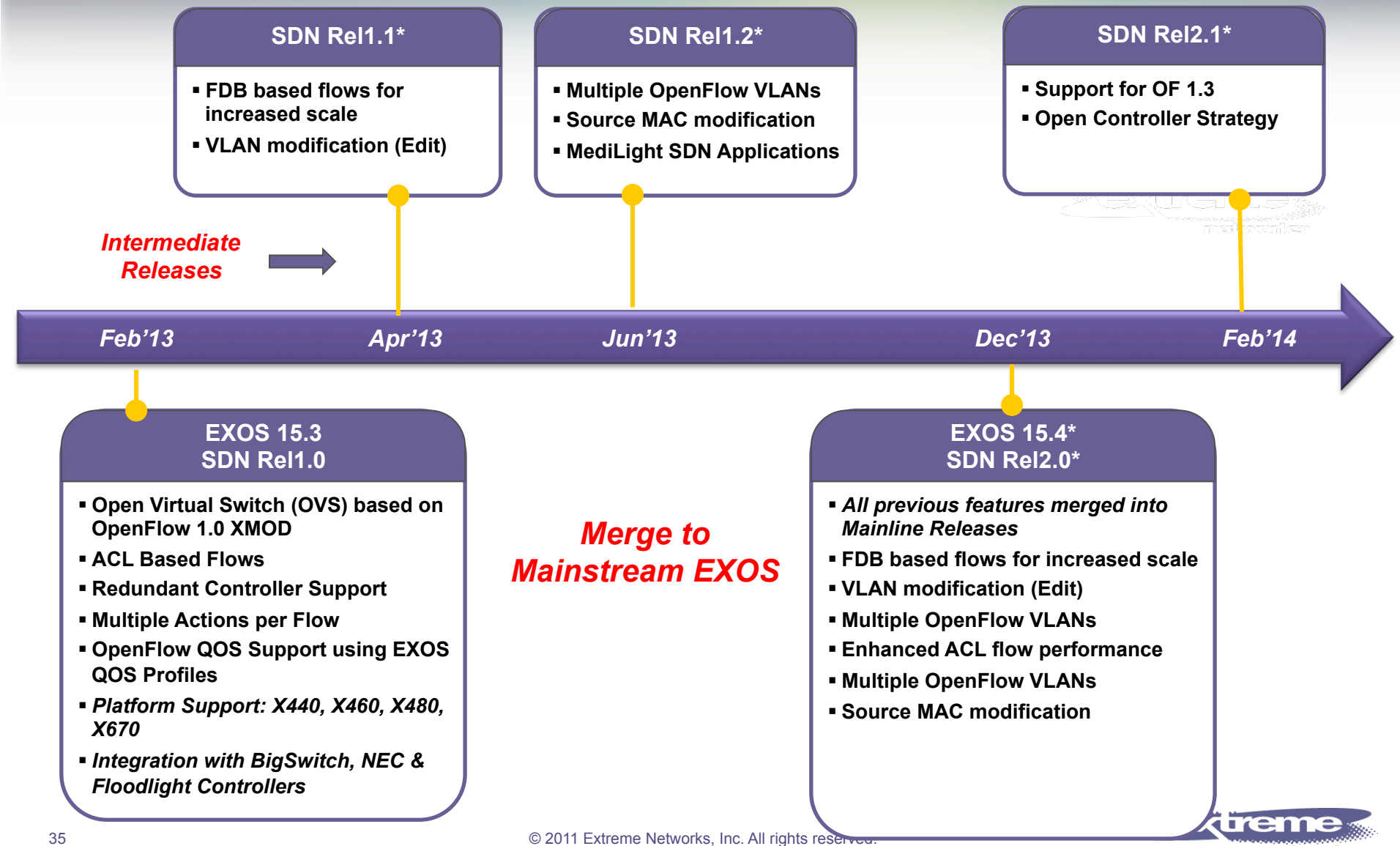
OpenFlow Implementation Plan-of-Record*

*FUTURE AVAILABILITY – PRODUCTS AND FEATURES SUBJECT TO CHANGE



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OpenStack Implementation Plan-of-Record*

*FUTURE AVAILABILITY – PRODUCTS AND FEATURES SUBJECT TO CHANGE

DROP 1

- HA on management ports
- Porting to Grizzly
- Provider Network Extension API

DROP 2

- VR Insertion API
- SR-IOV Data Model

DROP 3

- API for Router Configuration

DROP 4

- QoS Rate limiting per Quantum port Profile Management.

Intermediate Releases to

Feb'13 ***Aug'13*** ***Oct'13*** ***Nov'13*** ***Dec'13*** ***Feb'14***

SDN 1.0
OpenStack Release 1.0

- Quantum based on Folsom
- Topology Aware Scheduler
- *VLAN & VMAN configuration through API for Multi-tenancy*
- *Live VM Migration*

Merge to Mainstream EXOS

SDN 2.0*
Openstack Release 2.0

- All features from intermediate drops merged

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Controller & Applications

Multi-Vendor Interoperability & Applications with OpenFlow

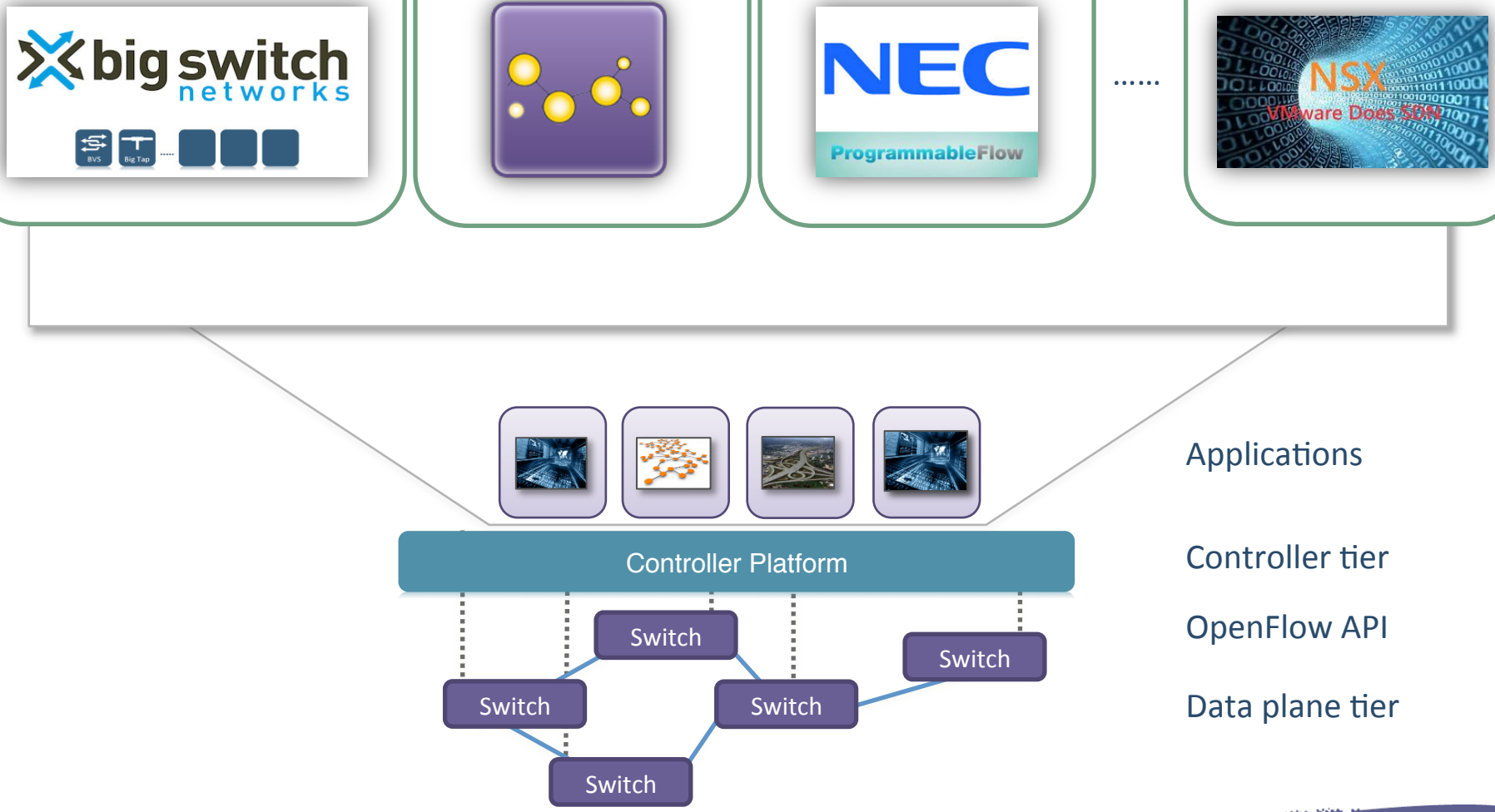
Future Support

Big Switch

Floodlight

NEC

VMware



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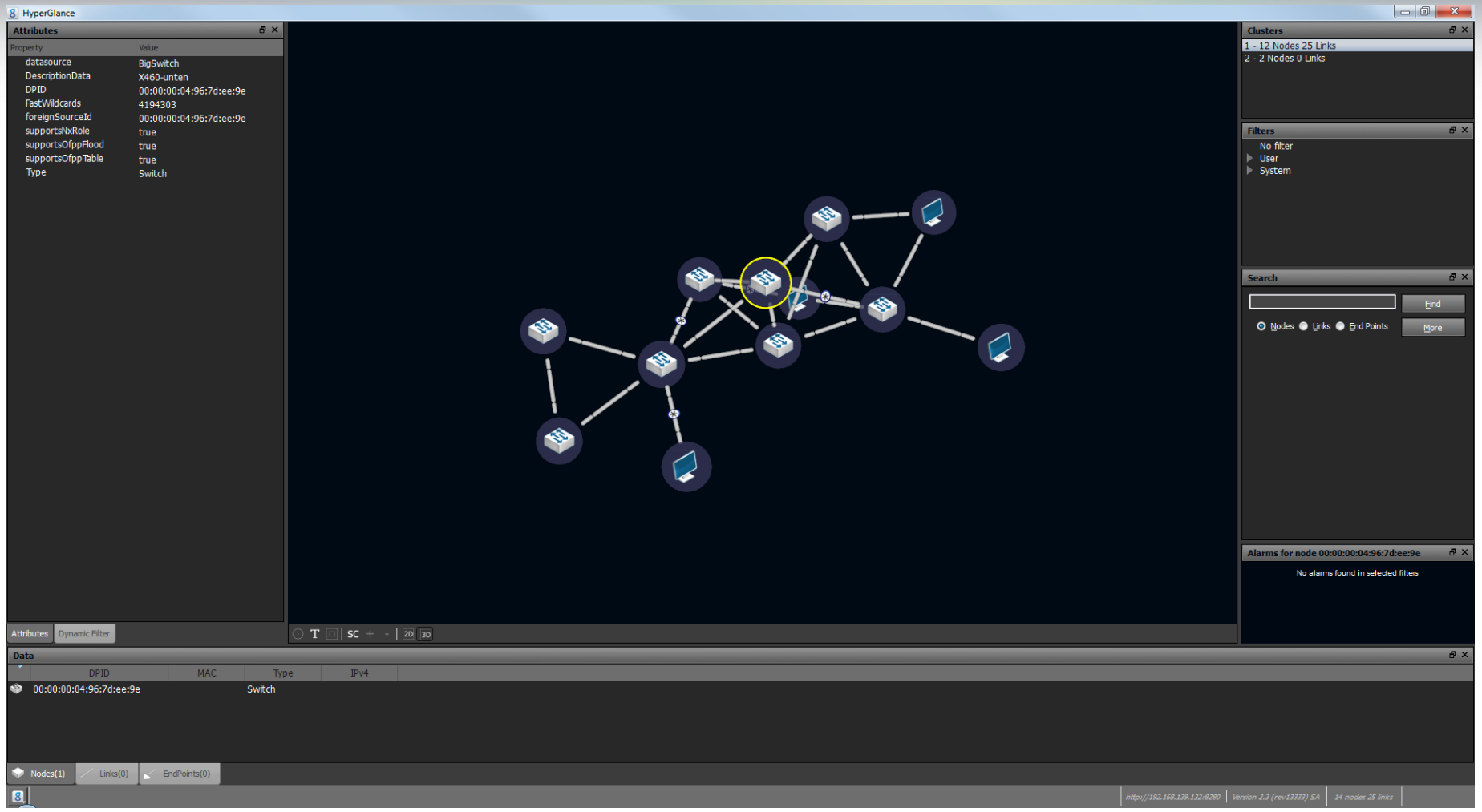
Big Network Controller mit Hyperglance



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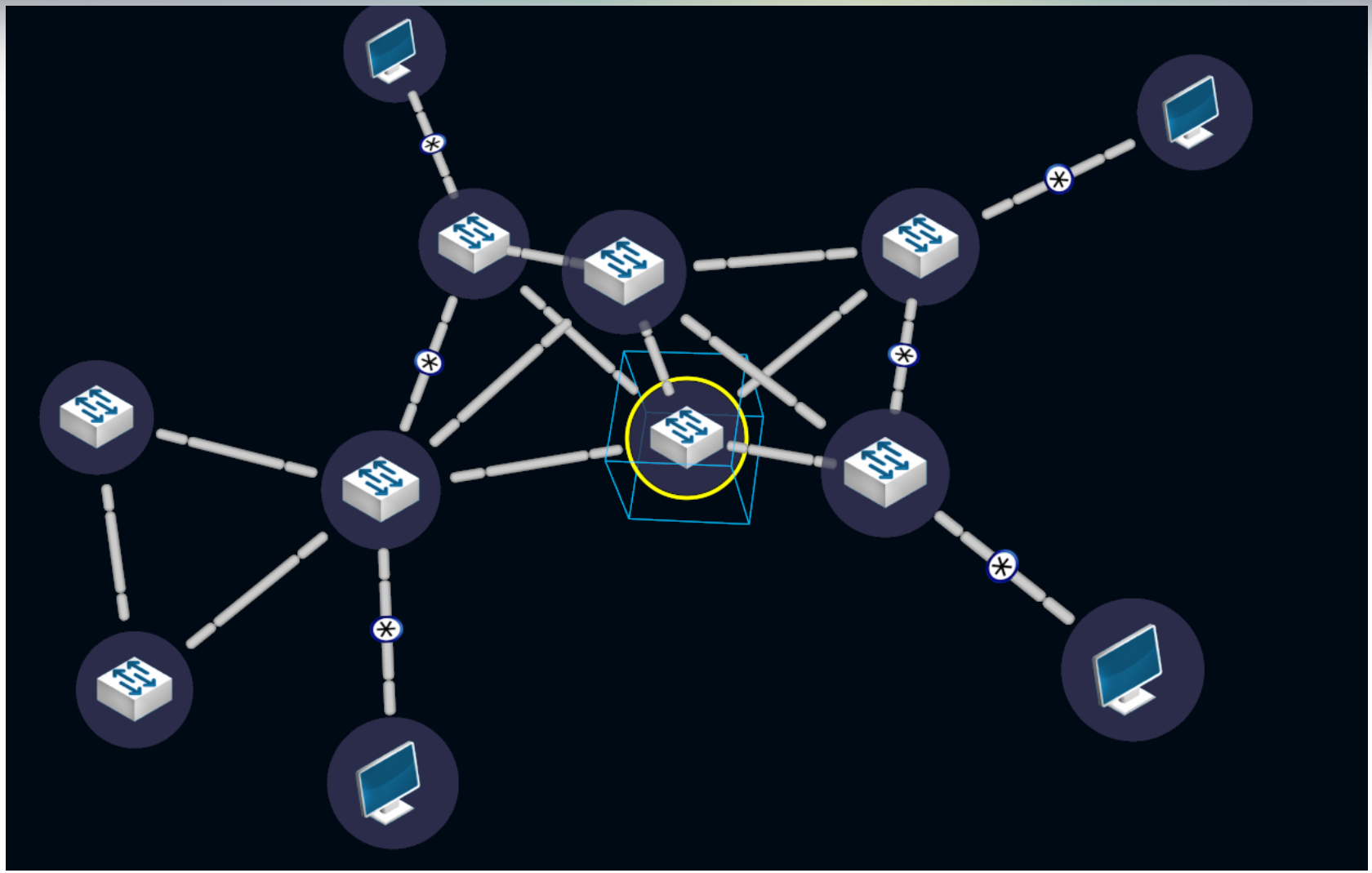
Big Network Controller mit Hyperglance



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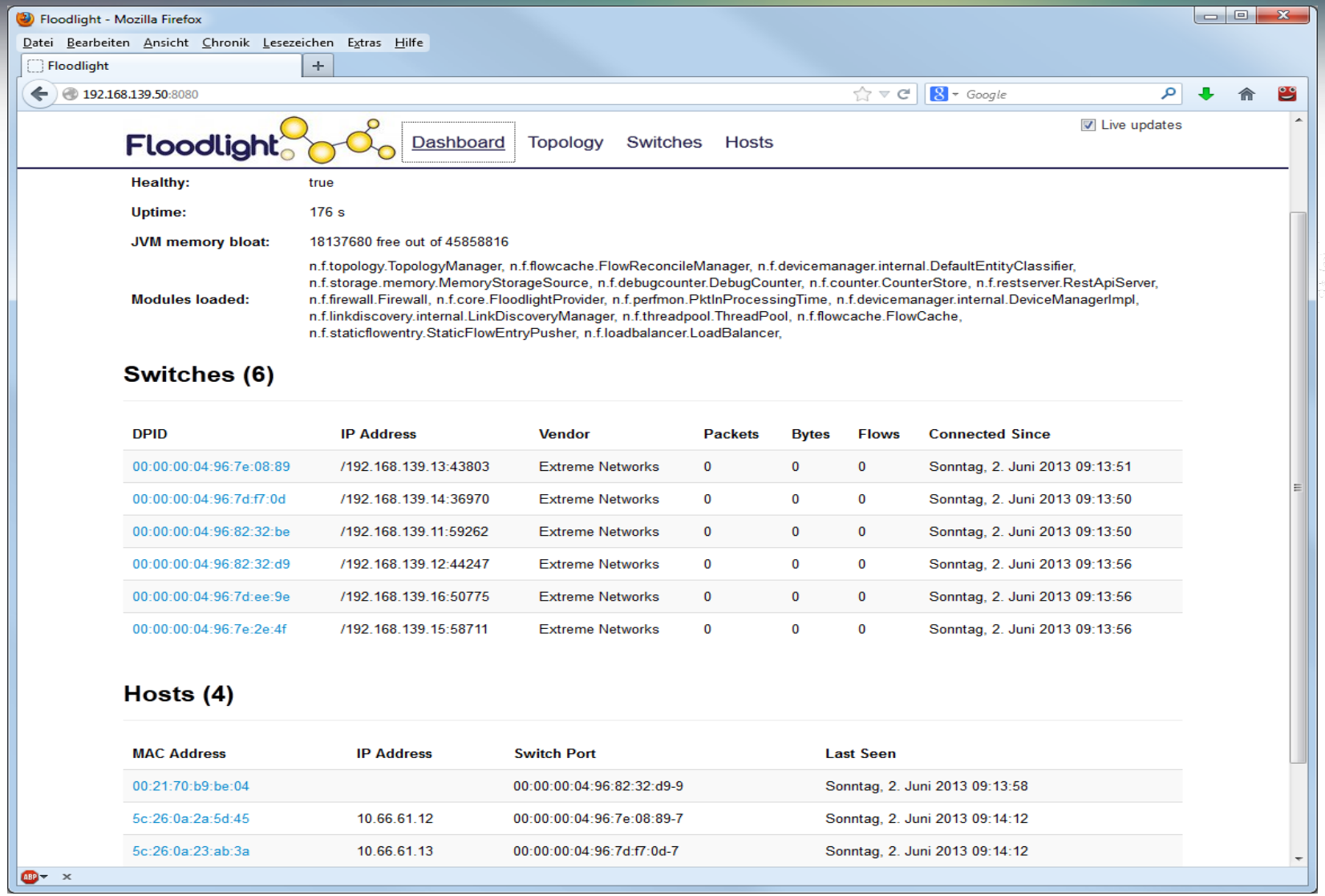
Floodlight Dashboard



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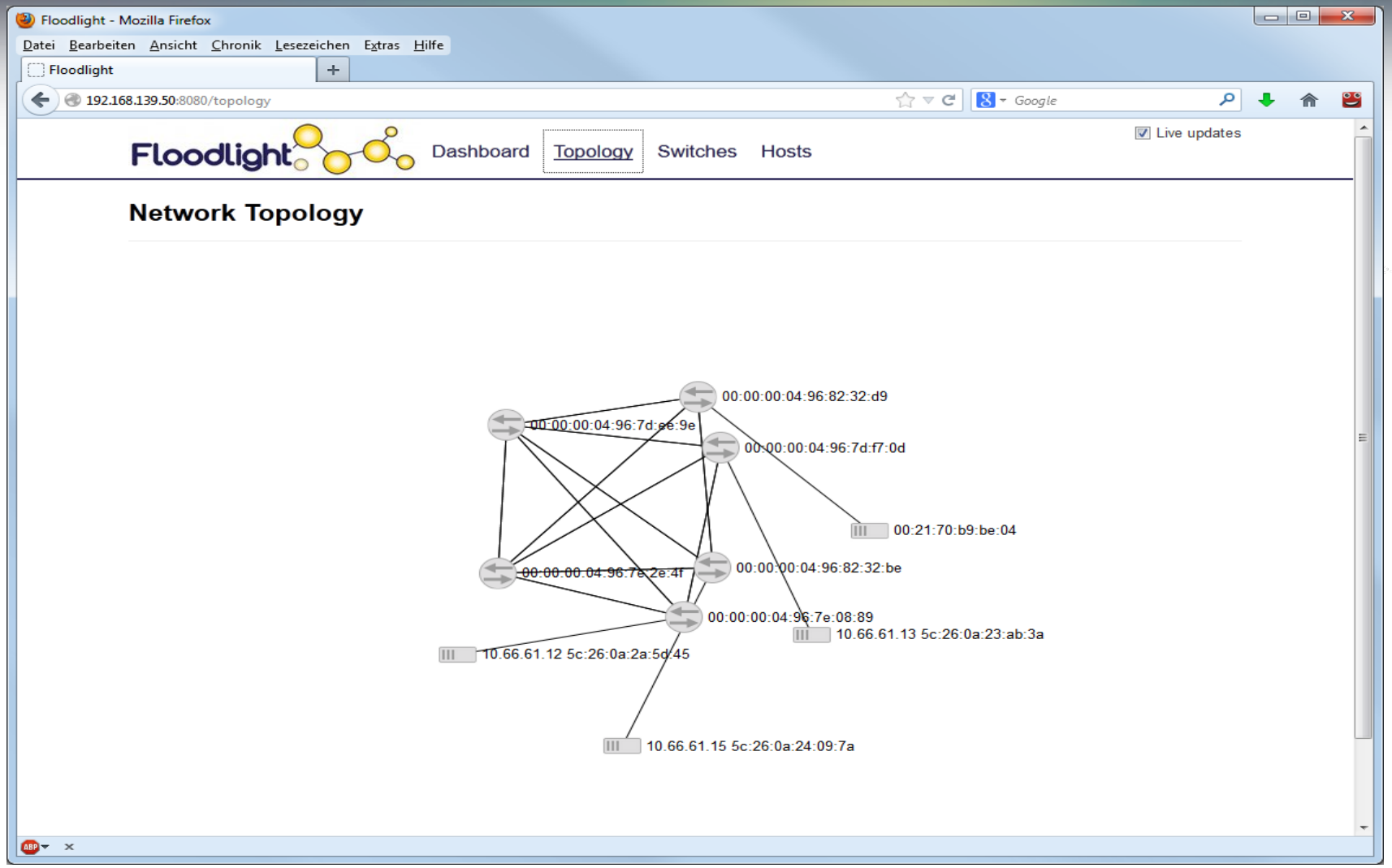
Floodlight Topology View



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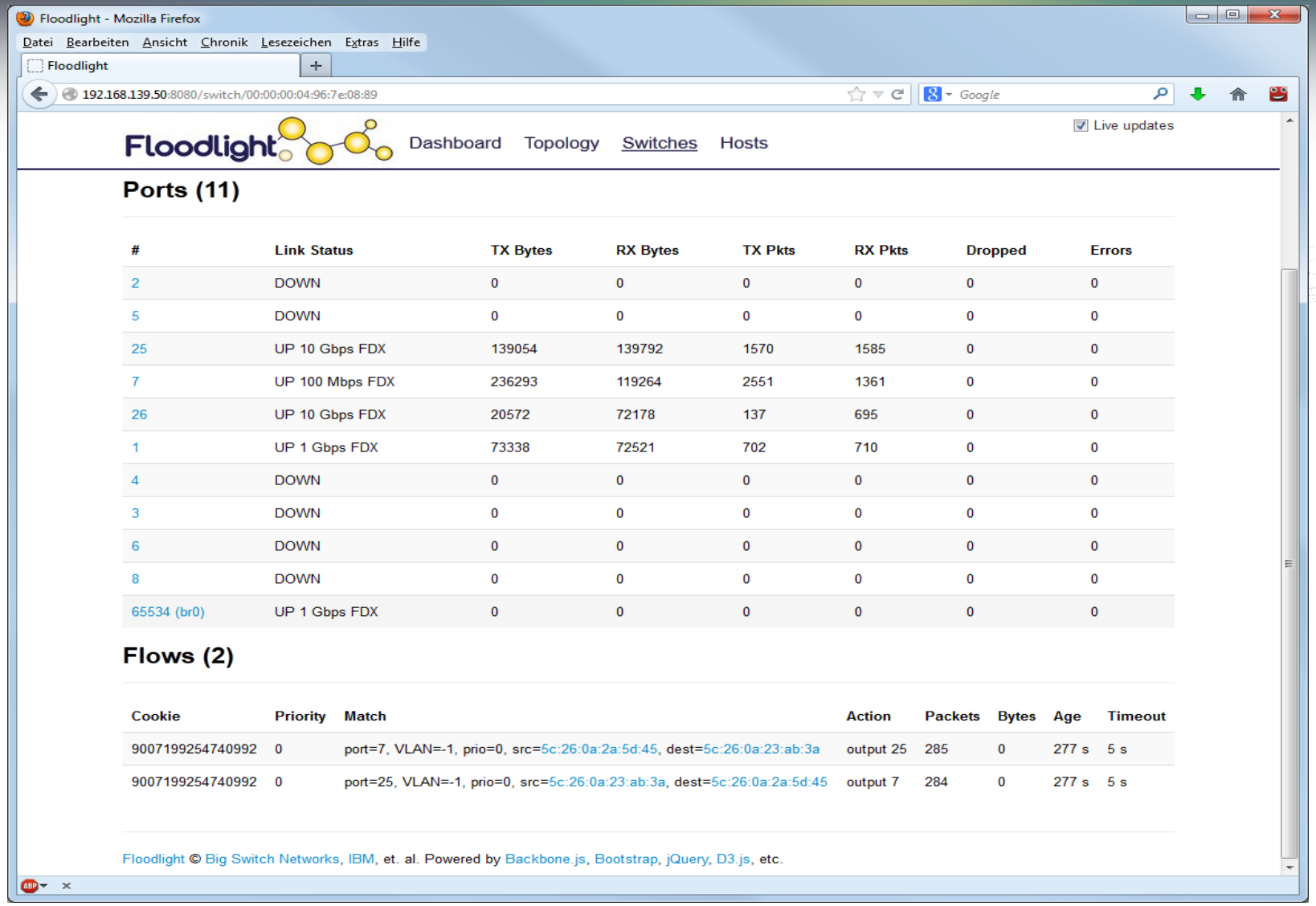
Floodlight Switchview Detail



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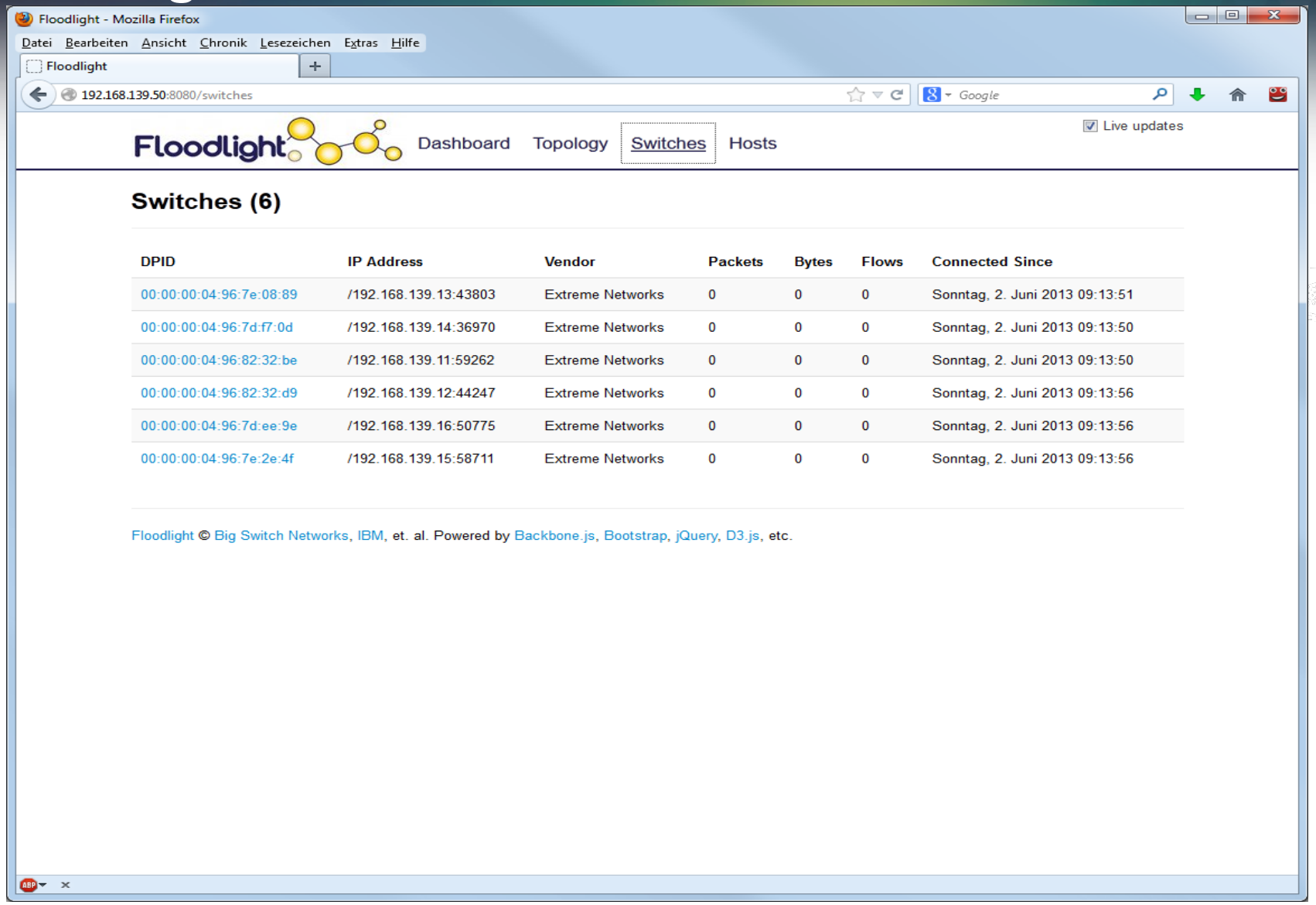
Floodlight Switchview



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Software-Defined Networking: Myths vs. Reality

"SDN is just a research topic"

⇒Seeing real production deployments for early adopters, moving to early majority

"OpenFlow can (can't) solve any real-world network problem"

⇒OpenFlow is at version 1.0 and can solve a few problems well, but is expanding

⇒Key point: it is a *control* (not a data) protocol

"SDN == OpenFlow"

⇒OpenFlow is an ***open, standard*** protocol between the control & data planes in an SDN architecture

"SDN == Network Virtualization"

⇒Network Virtualization is an important, key application for SDN, but others are possible

"We've been doing SDN with scripts for years…"

⇒There has been a trend toward central controllers, but a programmable dataplane is different from configuration automation

"OpenFlow can't scale"

⇒Google's entire datacenter backbone runs on OpenFlow 1.0

"SDN/OpenFlow deployment is rip-and-replace "

⇒All our current deployments have SDN/OpenFlow interoperating with existing networks

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Architectural Disruptions

Open architectures bring waves of innovation

Open Architectures

Drupal WordPress Joomla!

php perl python

Apache MySQL

Linux OS

X86 Architecture

android

iOS

?

Disruption

Closed, Proprietary Systems

Compute Mobile Networking

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Looking to the Future of SDN and OpenFlow

OpenFlow becomes the Android of networking

- Open network OS and controller for Ethernet switches and routers
- OpenFlow and related specifications all available as Open Source

Apps for every need

- From QoS, to PBR, to Identity Management, to Mobility Management, to multi-tenancy and so on

Controller vendors eventually become application developers

- Apps come in free, premium, and freemium models

Switch vendors continue to build and sell switches

- Much like phone vendors continue to sell phones

App Stores and Marketplaces for OpenFlow and SDN Apps

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And the Hardware.....?

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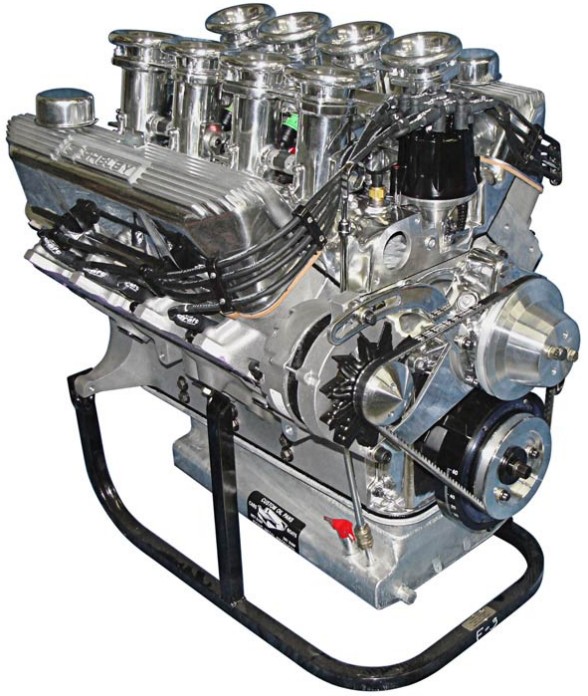
.....still matters!



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THANK YOU